

INSTALLATION AND TEST  
OF A  
THREE - TON YORK REFRIGERATING PLANT

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ARMOUR INSTITUTE OF TECHNOLOGY

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Bradford, Jesse Dudley

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three-ton York







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OF A  
THREE-TON YORK REFRIGERATING PLANT  
A THESIS

PRESENTED BY

JESSE DUDLEY BRADFORD  
ALEXANDER F. ROBERTSON  
IRWIN NEWMAN

TO THE

PRESIDENT AND FACULTY

OF

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## PREFACE.

The Installation and Test of a Three Ton York Refrigerating Plant was conducted by the authors of this report at the Armour Institute Laboratory Building on Dearborn Street, Chicago, Ill., from September 1912 to May 1913. This installation and test was under the direct supervision of Prof. E. S. Libby of the Mechanical Department of Armour Institute of Technology. Special mention is due to the following men, who assisted in the running of the test:

Mr. L.H. Philleo,  
Mr. M. D. Wald,  
Mr. John Wintercorn,  
Mr. E. A. Hager,  
Mr. H. E. Erickson,  
Mr. L. C. Meyer,  
Mr. H. Himmelblau,  
Mr. R. G. Bohn,  
Mr. T. J. Kiene,  
Mr. Wm. Smith,  
Mr. A. J. Dew.



## INSTALLATION AND TEST OF A THREE TON YORK REFRIGERATING PLANT.

### OBJECT.

The original intention was to install all the apparatus applying to a three ton York refrigerating plant, and to make a complete test of same, determining especially the heat losses in the ammonia lines with non-insulated pipes. Due to the time required for the installation, a complete test could not be made. However a simple test consisting of the making of ice was carried out, determining the tons of ice produced per ton of coal, per indicated horse power of each cylinder, and per boiler horse power. Other general data besides that actually needed was also taken.

### INSTALLATION.

The installation consisted of moving the apparatus from the old building at 3327 So. Dearborn Street to the new, in putting in the concrete foundations and trenches for the various apparatus, in setting the apparatus in place and in connecting same with suitable piping. This



order was not carried out in rotation but was followed with consistency. The plant when completed consisted of the following apparatus:

- 1 25 H.P. Erie Economic boiler
- 1 6 x 6 vertical York compressor direct connected to a 6 x 6 horizontal steam engine
- 1  $5\frac{1}{2}$  x  $3\frac{1}{2}$  x 5 Worthington pump for circulating the brine
- 1 Wheeler surface condenser
- 1 4 x 6 x 6 Marsh vacuum pump
- 1 Double tube ammonia condenser
- 1 Double tube ammonia expansion coils
- 2 Ammonia receivers
- 1 Ammonia accumulator
- 1 5'-3" x 14'-0" x 3'-0" freezing tank containing 35 100 pound pans for ice
- 1 Set of expansion coils in freezing tank
- 1 Oil separator in the ammonia discharge line
- 1 Automatic ice dump
- 1 automatic can filler
- 1 Metropolitan injector.





All apparatus for a distilled water ice system was provided but was not connected up before the test was run, so all ice was made from city water.

#### BOILER.

The boiler is of the return tubular type with self contained fire box. It was built by The Erie City Iron Works and rated at 25 H.P. The lower pass contains 18 4" tubes 4'-2 $\frac{1}{2}$ " long making 186.5 square feet of heating surface. The upper pass contains 30 3" tubes 7'-11 $\frac{1}{2}$ " long making 79.3 square feet of heating surface. The total heating surface is 265.8 square feet. The grate surface is 10.5 square feet. This makes the ratio of heating to grate surface 25.3. The stack is 18" inside diameter and about 35 feet in height. Water is fed to the boiler by means of an injector through a one inch pipe. The boiler is equipped with all the safety appliances demanded by the city.



ENGINE and COMPRESSOR.

The engine is a 6 x 6 horizontal steam engine of the "D" slide valve type direct connected to a 6 x 6 vertical York compressor. Both cylinders are equipped with indicator cocks. The compressor was designed to operate with zero clearance and for that reason is provided with a false head. In case a slug of liquid ammonia or any other solid matter should enter the cylinder this head, which is held down by a heavy car spring, will raise and thus prevent severe damage to the machine. The discharge valve is located in this false head and the suction valve in the piston. cooling is provided for by an open water jacket of the overflow type. The compressor is lubricated by means of a hand force feed lubricator and the engine by an hydrostatic lubricator. Smooth running is insured by two 3'-0" flywheels having 5" faces.

CONDENSERS.

In order that the engine may be run condensing a Wheeler surface condenser is provided. This is placed in a pit directly below



the engine. It contains 41 tubes in the first pass and 53 in the second, both being  $5/8$ " outside diameter and  $47\ 1/8$ " long. This gives 60.4 square feet of steam surface and 45.3 square feet of water surface. Connected to this condenser is a 4 x 6 x 6 Marsh vacuum pump.

The ammonia condenser of the double tube type consists of one bank of  $1\ 1/2$ " pipes inside of 2" pipes, 3 pipes high and 18 feet long. This condenser is placed upon brackets along the north wall. A gallery along the same wall gives access to this as well as to the expansion coils.

#### STEAM PIPING.

A  $2\ 1/2$ " steam header leads from the boiler to the north wall terminating in a tee. About halfway between the boiler and the wall a 2" lead takes steam to the engine. Just above the throttle valve this is bushed to 1". The brine circulating pump takes steam through a 1" pipe from one branch of the tee in the end of the main header. From the other branch a  $1\ 1/2$ " pipe runs to the east wall where it is bushed to 1" and leads to the injector. The drawing of the steam piping shown later will make this clear.



EXHAUST PIPING.

The engine exhaust pipe is  $1\frac{1}{2}$ " and the brine pump  $1\frac{1}{2}$ ". Both lead to a 2" exhaust header which either exhausts to the atmosphere or can be by passed through the condenser. The Marsh pump exhaust is  $\frac{3}{4}$ " and also leads to the exhaust header.

AMMONIA PIPING.

All the ammonia piping is  $1\frac{1}{2}$ " extra heavy for the gas and  $\frac{1}{2}$ " extra heavy for the liquid except in a few places where thermometer cups are inserted in the liquid lines. In these places it is either  $\frac{3}{4}$ " or 1". The ammonia gas is discharged through an oil separator into the double pipe condenser where it is liquified. The liquid then goes to the two receivers, which are mounted on platform scales so that the weight of ammonia used can be determined. From the receivers the ammonia is forced to the double pipe expansion coils or to the expansion coils in the freezing tank. From the expansion coils the gas is drawn back to the machine, and the cycle is then repeated. There is also an ac-





cumulator in the line but the piping is so arranged that it does not have to be used unless so desired. The drawing of the ammonia piping shows the arrangement of all by passes, etc.

#### BRINE SYSTEM.

Provision is made for freezing ice either by expanding the ammonia in the coils in the freezing tank or by circulating brine which has been cooled by the double pipe expansion coils which are placed on the gallery. The expansion coils on the gallery consist of one bank of  $1\frac{1}{2}$ " pipes inside of 2" pipes, 2 pipes high and 12 feet long.

The brine is circulated by means of a  $5\frac{1}{2}$  x  $3\frac{1}{2}$  x 5 "Worthington duplex pump. When ice is made by the latter method stated above the brine is pumped from the freezing tank through the double pipe cooler and into the weighing tanks and from there it gravitates back to the freezing tank. By this method the brine can be weighed.



FREEZING TANK.

The freezing tank 14'-0" long, 5'-3" wide and 3'-6" deep. It is made of sheet steel riveted together and reinforced around the top with angle irons. It is insulated from the concrete pit in which it is placed by 6" of cork felt on all sides and the bottom. In the tank are 6 banks of  $1\frac{1}{2}$ " pipes 8 pipes high connected to a 4" gas header at the top and a 4" liquid header at the bottom. This tank holds 33 cans 8 x 13 x 32 each can having a capacity of 100 pounds of ice. When the ice is frozen by the direct expansion of the ammonia in the coils in this tank the pump then merely furnishes circulation of the brine in the tank itself.

WATER PIPING and SUPPLY.

The water is brought into the building at the west end through a  $\frac{3}{4}$ " line. From there a  $1\frac{1}{2}$ " line runs to the point where the water branches to go to the ammonia and steam condensers, at which point a  $1\frac{1}{2}$ " line goes to each. In the ordinary operation the water first passes over ammonia and then over the steam condenser and back



to the weighing tank and then to the sewer. The water can be by passed to the steam condenser without running through the ammonia condenser or vice versa. The feed water for the boiler is taken from part of the circulating water after it has passed through the condensers.

#### PRELIMINARY TEST.

Steam pressure was first gotten up on May 13, 1913 and the system was put under an air pressure of 190 pounds per square inch. In this way the larger leaks were found and remedied. This pressure was allowed to remain on the system over night. The gauges showed a drop in pressure by the following morning which indicated more leaks. After steam had been gotten up on the next day a pressure was then applied and most of these leaks fixed. In the afternoon of this same day, May 14, 1913, the system was given a little charge of ammonia and the leaks detected with sulphur sticks. These leaks were mostly around the stuffing boxes of the valves



and around some of the flanges. On the next day May 15, 1913, the system was charged with 100 pounds of ammonia under a pressure of about 100 pounds per square inch. This was allowed to stand over night. No leaks being apparent in the morning the remaining 150 pounds was put into the system. This was on Friday, May 16, 1913.

#### FINAL TEST.

On Monday, May 19, 1913, steam was gotten up and the compressor started. No readings were taken however until Wednesday, May 21, 1913, because it was necessary to let the system get into running condition. Before starting up on Monday the ice cans had been filled and on Tuesday afternoon as most of the cans were frozen by that time they were pulled every hour and refilled. This was carried out in rotation and by the time all of the cans had been pulled the first one was frozen. It was then that readings were first taken. During this time of waiting every thing was gotten ready to make the run. The run started at 7:00 P. M. on Wednesday, May 21, 1913, and ended on Friday, May 23, 1913, at 7:00 P. M.





This covered a period of 48 hours. The readings were taken every half hour and also indicator cards from each cylinder. The coal was weighed out as needed as also was the ashes. Below are listed the readings that were taken;

Ammonia Suction pressure

Ammonia discharge pressure

Boiler pressure

Steam pressure at engine

Temperature in calorimeter at boiler

Temperature in calorimeter at engine

Temperature of gas entering the compressor

Temperature of gas leaving the compressor

Temperature of gas entering condenser

Temperature of liquid leaving the cond.

Temperature of gas leaving coils in tank

Temperature of brine

Temperature water entering condenser

Temperature of water leaving condenser

Temperature of feed water

Temperature of room

The weight of condensing and feed water for the entire run.



A can of ice was pulled every hour, three quarters of an hour and every half hour, depending on the number of cans that were frozen ahead of the one that was being pulled. The log sheet shows the time at which the pulling took place as well as all data taken during the test. The coal used for the test was a mixture of hard and soft coal. The following pages give, in tabulated form, the areas and lengths of the indicator cards taken and following that is a table of the average results of the test and also of the calculated results. A sample calculation will be found in the appendix.



## AREAS AND LENGTH OF CARDS

Time.	Steam Cyl.		Length.	Ammonia Cyl.	
	H. E.	C. E.		Area.	Length.
P.M.					
7:00	2.82	2.63	2.98	----	3.3
7:30	2.77	2.53	"	----	"
8:00	2.74	2.65	"	----	"
8:30	2.62	2.60	"	----	"
9:00	2.53	2.50	"	----	"
9:30	----	----	"	----	"
10:00	2.69	2.63	"	----	"
10:30	2.68	2.55	"	1.06	"
11:00	2.65	2.63	"	1.00	"
11:50	----	----	"	----	"
12:00	2.66	2.60	"	1.00	"
12:30	2.60	2.63	"	1.13	"
1:00	2.70	2.62	"	.90	"
1:30	2.73	2.63	"	.96	"
2:00	----	----	"	.84	"
2:30	----	----	"	.96	"
3:00	2.57	2.45	"	.93	"
3:30	2.55	2.40	"	.92	"
4:00	2.52	2.37	"	.87	"
4:30	----	----	"	1.00	"



Time. A.M.	Steam Cyl.		Length.	Ammonia Cyl.	
	H. E.	C. D.		Area,	Length.
5:00	2.50	2.40	2.98	.89	3.3
5:30	----	----	"	.89	"
6:00	2.53	2.55	"	.93	"
6:30	2.70	2.66	"	.94	"
7:00	----	----	"	.87	"
7:30	----	----	"	.90	"
8:00	----	----	"	----	"
8:30	2.33	2.77	"	.96	"
9:00	----	----	"	----	"
9:30	----	----	"	.92	"
10:00	----	----	"	.92	"
10:30	----	----	"	.87	"
11:00	2.35	2.67	"	.94	"
11:30	----	----	"	.93	"
12:00	2.43	2.53	"	.96	"
12:30	----	----	"	----	"
1:00	2.38	2.76	"	.98	"
1:30	----	----	"	1.04	"
2:00	2.72	2.62	"	1.03	"
2:30	----	----	"	1.04	"





Time. P.M.	Steam Cyl. Area			Ammonia Cyl.	
	H. E.	C. E.	Length.	Area.	Length.
3:00n	2.61	2.47	2.98	1.03	3.3
3:30	2.43	2.40	"	1.14	"
4:00	----	----	"	1.03	"
4:30	----	----	"	1.11	"
5:00	2.88	2.79	"	<del>1.96</del>	"
5:30	----	----	"	.99	"
6:00	3.05	2.39	"	.82	"
6:30	-----	----	"	----	"
7:00	2.32	2.65	"	----	"
7:30	----	----	"	.77	"
8:00	2.79	2.70	"	.35	"
8:30	----	----	"	.38	"
9:00	2.75	2.57	"	.36	"
9:30	----	----	"	.78	"
10:00	2.32	2.67	"	.32	"
10:30	-----	----	"	.79	"
11:00	2.90	2.80	"	.67	"
11:30	----	----	"	.66	"
12:00	2.35	2.76	"	.76	"
12:30	----	----	"	.61	"



Time. A.M.	Steam Cyl. Area		Length.	Ammonia Cyl.	
	H. E.	C. E.		Area.	Length.
1:00	2.90	2.76	2.93	.74	3.3
1:30	----	----	"	.73	"
2:00	----	----	"	.80	"
2:30	----	----	"	.79	"
3:00	2.55	2.35	"	.87	"
3:30	2.60	2.47	"	.82	"
4:00	2.49	2.38	"	.86	"
4:30	----	----	"	.88	"
5:00	2.62	2.52	"	.87	"
5:30	----	----	"	.80	"
6:00	----	----	"	.96	"
6:30	2.73	2.64	"	----	"
7:00	2.85	2.67	"	----	"
7:30	2.87	2.83	"	.98	"
8:00	2.92	2.87	"	.96	"
8:30	----	----	"	1.05	"
9:00	3.13	3.02	"	1.10	"
9:30	----	----	"	1.01	"
10:00	2.95	2.76	"	.87	"
10:30	----	----	"	.87	"



Steam Cyl.  
Area

## Ammonia Cyl.

Time. A.M.	H. E.	C. E.	Length.	Area.	Length.
11:00	2.90	2.76	2.98	1.10	3.3
11:30	----	----	"	1.07	"
12:00	2.85	2.65	"	1.17	"
12:30	----	----	"	1.06	"
1:00	----	----	"	1.05	"
1:30	2.98	2.76	"	1.13	"
2:00	----	----	"	.97	"
2:30	----	----	"	----	"
3:00	----	----	"	.92	"
3:30	----	----	"	.92	"
4:00	----	----	"	.95	"
4:30	----	----	"	1.06	"
Average.	2.744	2.65	2.98	.916	3.30

Note:-

All spaces left blank are due to the cards  
being too faint to integrate or not taken.



AVERAGE RESULTS.

Time of run in hours	48
Speed, R. P. M.	137.7
Boiler pressure	83.5
Steam pressure at engine	53.1
Ammonia discharge pressure	121.2
Ammonia suction pressure	18.7
Room temperature	66.1
Feed water temperature	68.5
Temperature in calorimeter at boiler	217.0
Temperature in calorimeter at engine	219.0
Temp. gas entering NH <sub>3</sub> condenser	111.8
Temp. liquid leaving NH <sub>3</sub> Condenser	55.0
Temp. cooling water entering condenser	51.8
Temp. cooling water leaving condenser	62.5
Temp. gas entering compressor	60.0
Temp. gas leaving compressor	145.5
Temperature of brine leaving tank	5.0
Temperature of gas leaving coils in tank	3.4

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AVERAGE RESULTS (continued)

Barometer	29.306
Weight of coal, total,	3271
Weight of ash, total,	586
Weight of feed water, total,	17594
Weight of cooling water, total,	203798
Weight of ice, total,	8870.5

## Note:-

The barometer readings were obtained from the weather bureau.



CALCULATED RESULTS.

I. H. P. Steam cylinder head end	2.17
I. H. P. Steam cylinder crank end	2.00
Total I. H. P. Steam cylinder	4.26
Total I. H. P. Ammonia cylinder	1.64
Ratio of ammonia to steam I. H. P.	.385
Quality of steam at boiler, $\%$ ,	36.2
Quality of steam at engine, $\%$ ,	97.2
Apparent evaporation per pound of coal	4.43
Factor of evaporation	1.15
Equivalent evaporation	5.094
Boiler H. P.	30
Boiler and grate efficiency, $\%$ ,	41.25
Pounds of coal per 24 hours	1985.5
Tons of ice per 24 hours	1.668
Tons of ice per hour	.0025
Tons of ice per ton of coal	1.68
Tons of ice per I.H.P. hour of $NH_3$ cyl.	.0424
Tons of ice per I.H.P. hour of steam cyl.	.0163
Tons of ice per boiler H.P. hour	.0023



DISCUSSION.

On the whole this test has been a marked success as far as expectations were concerned. Very little trouble appeared throughout the preliminary or final tests and although every part of the plant did not operate in the most efficient way, the results were reasonable and fairly good.

The boiler and grate efficiency of 41.25% is fair for an ordinary return tubular boiler with hand firing. Part of the time soft coal was used and this was very satisfactory. Near the end of the test hard coal was tried but this was not as satisfactory so a mixture of half and half was tried and this was found to work better. With this mixture it was much easier to keep up the steam pressure.

The apparent evaporation of 4.43 ~~water~~ per pound of coal is somewhat low for economical running but this was to be expected of the boiler used.

The ratio of the I.H.P. of the ammonia cylinder to that of the steam cylinder - or as we might say the mechanical efficiency of the engine and compressor - is very low being only



38.5%. The cards of the steam cylinder show fairly good steam action in the cylinders but those of the compressor indicate that the valves did not operate as they should. On page 30 is shown an example of an ideal card which should be approached as near as possible. The average card is shown on page 31. This card shows a marked departure from the ideal. This is what causes the above efficiency to be so low.

The fact that the quality of the steam at the boiler is lower than that at the engine would seem to show that there was a separating effect in the line instead of a condensation effect, or else an unknown error has come into play. It may be that the steam was too wet to get accurate results from a throttling calorimeter.





## APPENDIX.

SAMPLE CALCULATIONS.

Indicated Horse Power:

Steam Cyl. Head End.

$$\begin{aligned}
 \text{M.E.P.} &= \frac{2.744 \times 40}{2.98} = 36.85 \text{ #/sq. in.} \\
 \text{I.H.P.} &= \frac{\text{P.L.A.E.}}{33000} = \frac{36.85 \times 28.27 \times 137.7}{2 \times 33000} \\
 &= 2.17 \text{ I.H.P.}
 \end{aligned}$$

Crank end.

$$\begin{aligned}
 \text{M.E.P.} &= \frac{2.63 \times 40}{2.98} = 35.33 \text{ #/sq. in.} \\
 \text{I.H.P.} &= \frac{\text{p.l.a.e.}}{33000} = \frac{35.33 \times 1 \times 28.27 \times 137.7}{2 \times 33000} \\
 &= 2.09 \text{ I.H.P.}
 \end{aligned}$$

Total I.H.P. = 4.26.

Ammonia cylinder.

$$\begin{aligned}
 \text{M.E.P.} &= \frac{.916 \times 100}{3.30} = 27.8 \text{ #/sq. in.} \\
 \text{I.H.P.} &= \frac{\text{P.L.A.E.}}{33000} = \frac{27.8 \times 1 \times 28.27 \times 137.7}{2 \times 33000} \\
 &= 1.64 \text{ I.H.P.}
 \end{aligned}$$

Ratio between I.H.P. of ammonia and steam

$$\text{cylinders} = \frac{1.64}{4.26} = .385.$$

Quality of steam at boiler = 96.2% (Mollier Diagram)

Quality of steam at engine = 97.2% ( " " )



Boiler calculations.

Apparent evaporation per pound of coal

$$\text{as fired} = \frac{17594}{3971} = 4.43\%$$

$$\begin{aligned} \text{Factor of evaporation} &= \frac{xr \quad q - (t - 32)}{\frac{1153 - 68.5}{970.4} \quad \frac{32}{970.4} \quad \frac{1116.5}{970.4}} \\ &= \frac{970.4}{970.4} = 1.15. \end{aligned}$$

Equivalent evaporation per pound of coal

$$\text{as fired} = 4.43 \times 1.15 = 5.0945\%$$

Heat absorbed by boiler per pound of coal

$$\text{as fired} = 970.4 \times 5.0945 = 4950 \text{ B.t.u.}$$

Assuming 12000 B.t.u. per pound as the calorific  
value of coal as fired

$$\text{Boiler and grate efficiency} = \frac{4950 \times 100}{12000 \times} = 41.25\%$$

$$\text{Boiler Horse Power} = \frac{34.5}{1.15} = 30 \text{ Boiler H.P.}$$

$$\text{Tons of ice per ton of coal} = \frac{6670.5}{3971} = 1.68.$$

Tons of ice per I.H.P.hr. of ammonia cyl.

$$\begin{aligned} &= \frac{.0695}{1.64} = .0424. \end{aligned}$$



Tons of ice per I.H.P. hr. of steam cylinder

$$= \frac{.6005}{4.26} = .0163$$

Tons of ice per boiler H.P. hr.

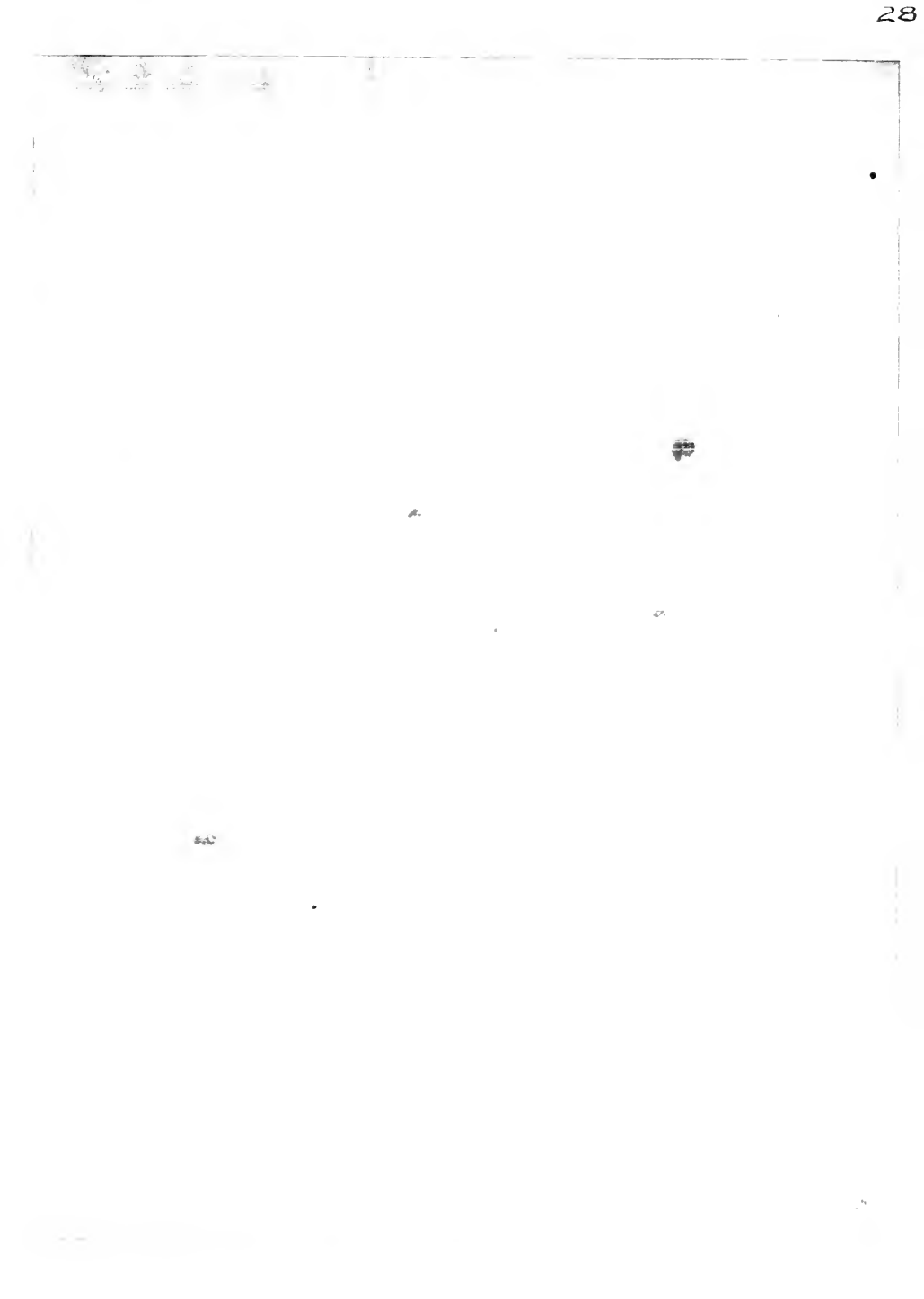
$$= \frac{.0695}{30} = .0023.$$



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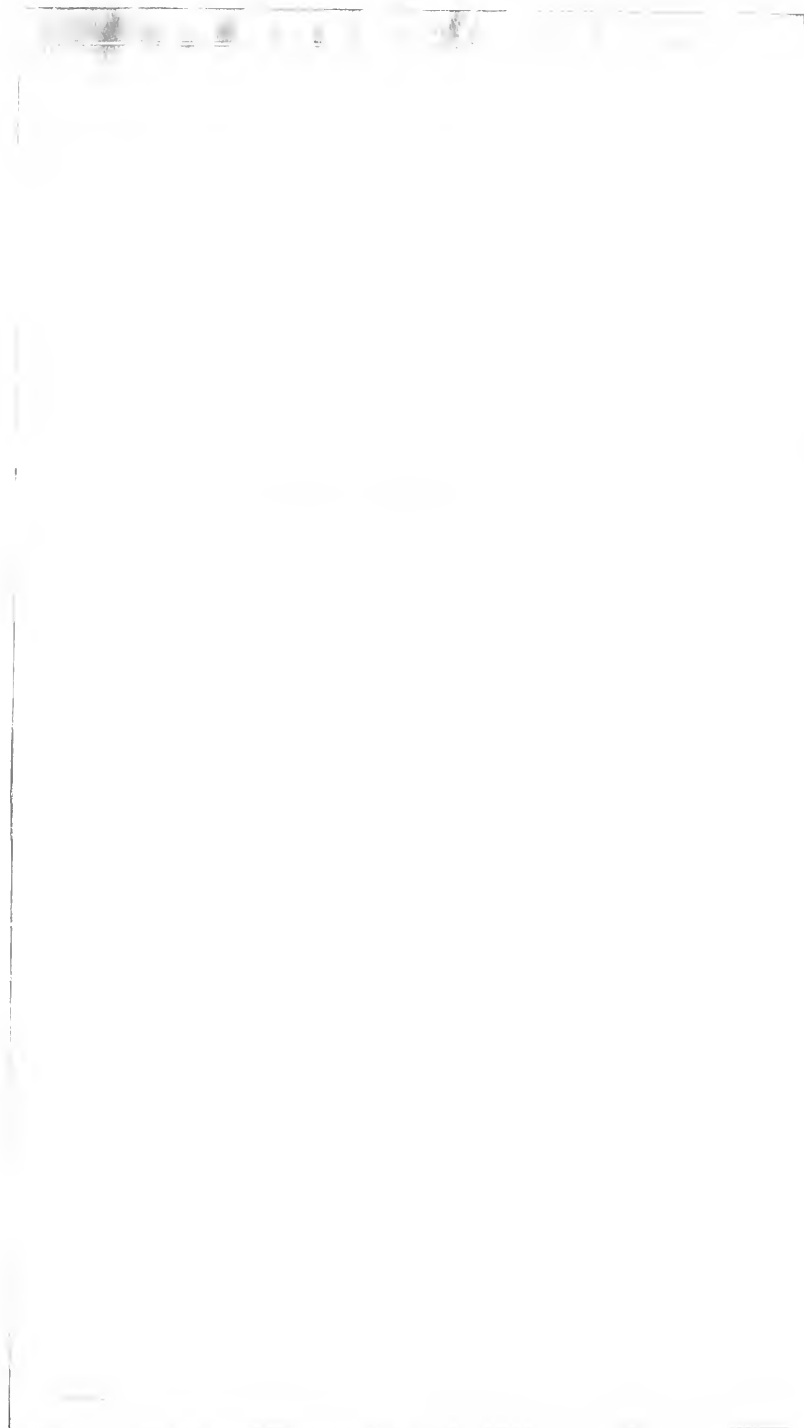
















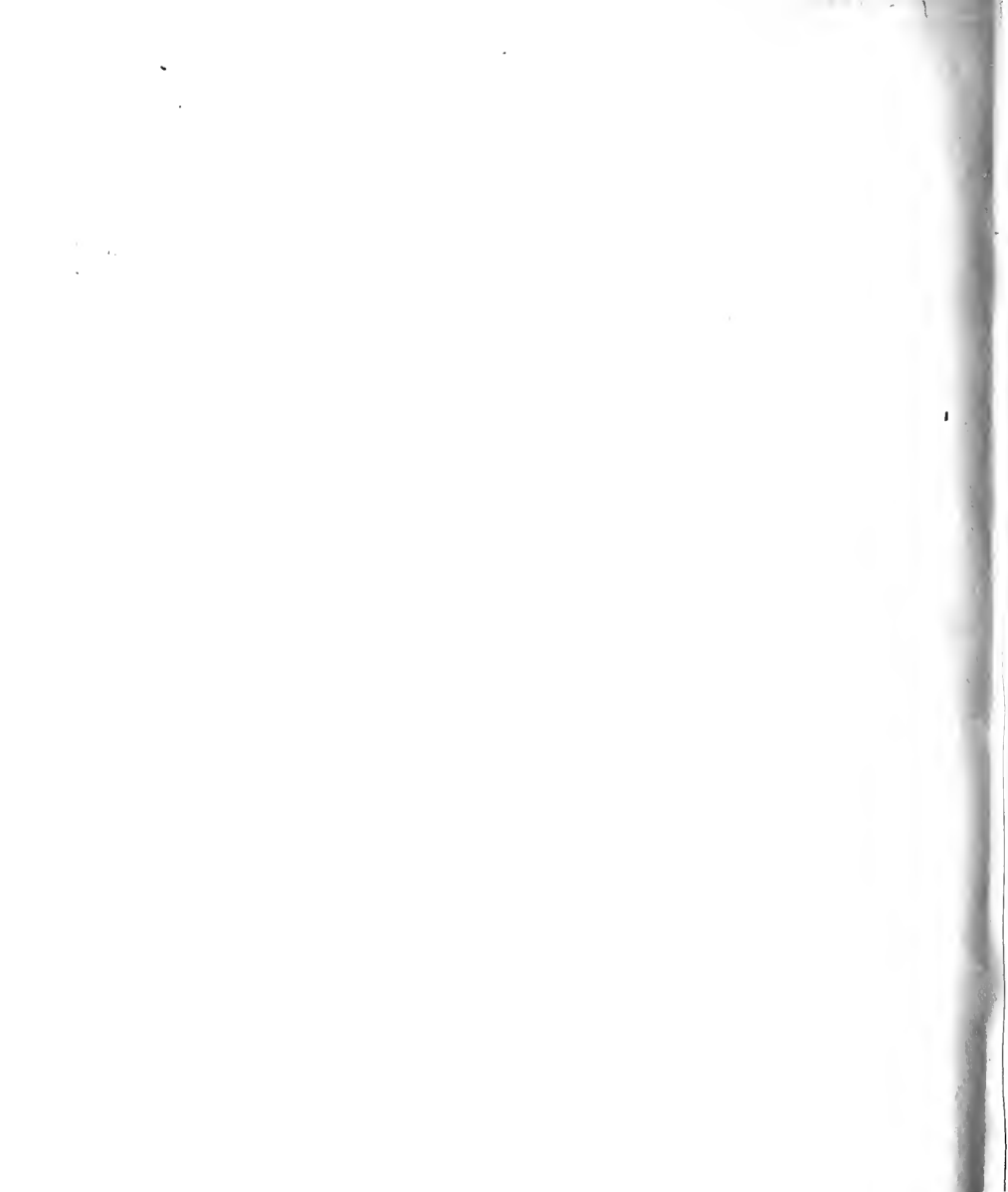
LOG SHEET #1.



[illegible]

$\alpha$	$10^{-10}$
$\beta$	$10^{-10}$
$\gamma$	$10^{-10}$
$\delta$	$10^{-10}$
$\epsilon$	$10^{-10}$
$\zeta$	$10^{-10}$
$\eta$	$10^{-10}$
$\theta$	$10^{-10}$
$\iota$	$10^{-10}$
$\kappa$	$10^{-10}$
$\lambda$	$10^{-10}$
$\mu$	$10^{-10}$
$\nu$	$10^{-10}$
$\xi$	$10^{-10}$
$\omicron$	$10^{-10}$
$\pi$	$10^{-10}$
$\rho$	$10^{-10}$
$\sigma$	$10^{-10}$
$\tau$	$10^{-10}$
$\upsilon$	$10^{-10}$
$\phi$	$10^{-10}$
$\chi$	$10^{-10}$
$\psi$	$10^{-10}$
$\omega$	$10^{-10}$
$\delta_1$	$10^{-10}$
$\delta_2$	$10^{-10}$
$\delta_3$	$10^{-10}$
$\delta_4$	$10^{-10}$
$\delta_5$	$10^{-10}$
$\delta_6$	$10^{-10}$
$\delta_7$	$10^{-10}$
$\delta_8$	$10^{-10}$
$\delta_9$	$10^{-10}$
$\delta_{10}$	$10^{-10}$
$\delta_{11}$	$10^{-10}$
$\delta_{12}$	$10^{-10}$
$\delta_{13}$	$10^{-10}$
$\delta_{14}$	$10^{-10}$
$\delta_{15}$	$10^{-10}$
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$\delta_{96}$	$10^{-10}$
$\delta_{97}$	$10^{-10}$
$\delta_{98}$	$10^{-10}$
$\delta_{99}$	$10^{-10}$
$\delta_{100}$	$10^{-10}$

[illegible]
$$\frac{\partial^2}{\partial t^2} \left( \frac{1}{r} \right) = -\frac{1}{r^3}$$



LOG SHEET #2



Handwritten notes in a cursive script, likely a ledger or account book. The text is organized into columns and rows, with some entries appearing to be dates or specific transactions. The handwriting is dense and somewhat difficult to decipher due to the cursive style.

Handwritten notes in a cursive script, continuing the ledger or account book. The entries are similar to the first page, with columns and rows of text. Some words are more legible than others, but the overall structure is consistent.

Handwritten notes in a cursive script, continuing the ledger or account book. The entries are similar to the first page, with columns and rows of text. Some words are more legible than others, but the overall structure is consistent.

Handwritten notes in a cursive script, continuing the ledger or account book. The entries are similar to the first page, with columns and rows of text. Some words are more legible than others, but the overall structure is consistent.

Handwritten notes in a cursive script, continuing the ledger or account book. The entries are similar to the first page, with columns and rows of text. Some words are more legible than others, but the overall structure is consistent.





LOG SHEET #3

Grand Ave  
Grand Ave  
Gr  
Gr  
Gr



1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
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21	22	23	24	25
26	27	28	29	30
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41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

1	2	3	4	5
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11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
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71	72	73	74	75
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81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

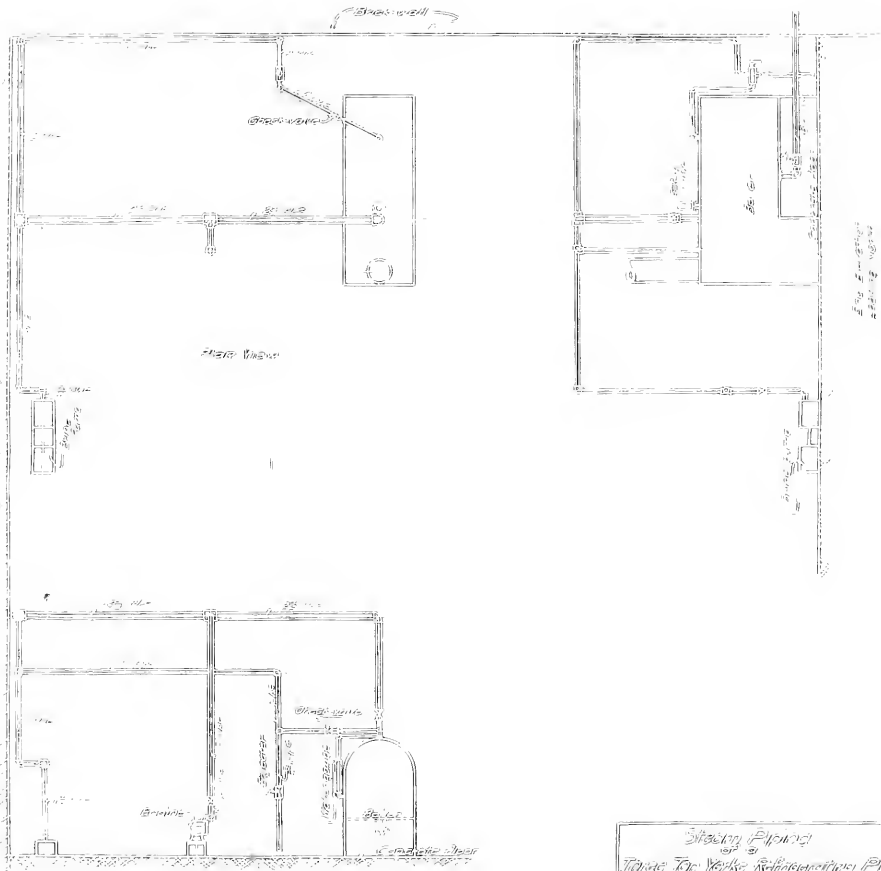
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46	47	48	49	50
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66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
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86	87	88	89	90
91	92	93	94	95
96	97	98	99	100

100



*STEAM PIPING*





Zeichnung  
 Plan der Werke der Reichsanstalt für  
 chemische Technologie, der Reichsanstalt  
 für chemische Technologie, der Reichsanstalt  
 für chemische Technologie





*AMMONIA PIPING*

